

FRESHWATER MUSSELS

in Western North America

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Nevada Department of Wildlife

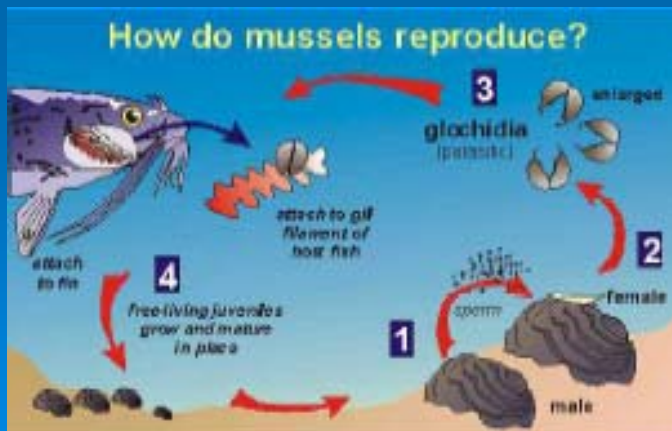


Defining Characteristics

Nacreous shell interior



Obligate parasitic life stage that requires a vertebrate host



Freshwater Mussel (Clam)

- Freshwater bivalve shellfish
- Phylum Mollusca, Class Bivalvia

- Order Unionoida – uses a host
 - Families: Unionidae and Margaritiferidae
 - Genera West of the Rocky Mountains:

Anodonta, Gonidea, Margaritifera

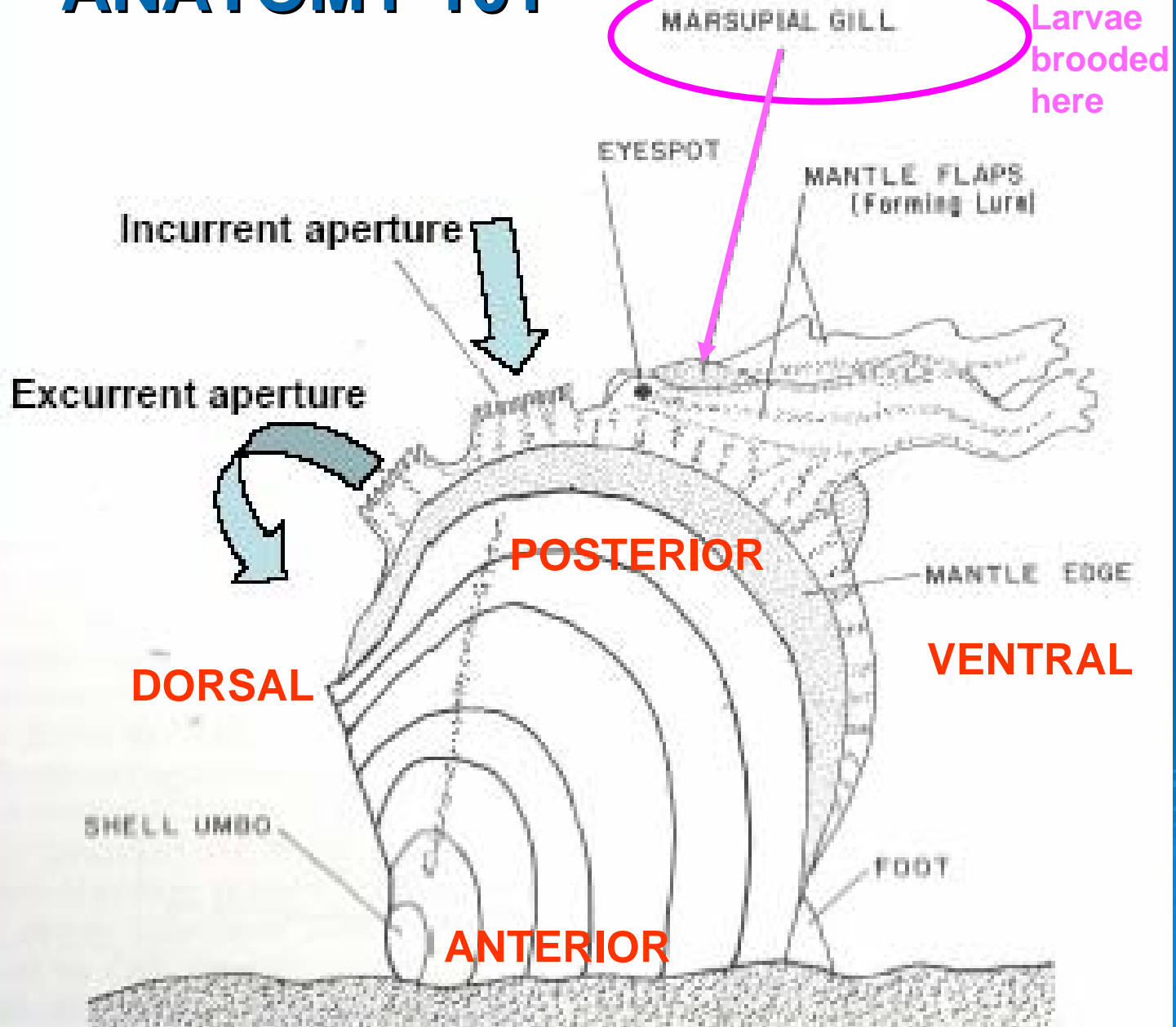


THESE ARE **NOT** FRESHWATER MUSSELS:

- Order Veneroida – does not use a host
 - Family Corbiculidae (Asian clam – **introduced**)
 - Family Sphaeriidae/Pisididae (fingernail or pea clam)



ANATOMY 101



“Western North America”



Jerry Malone



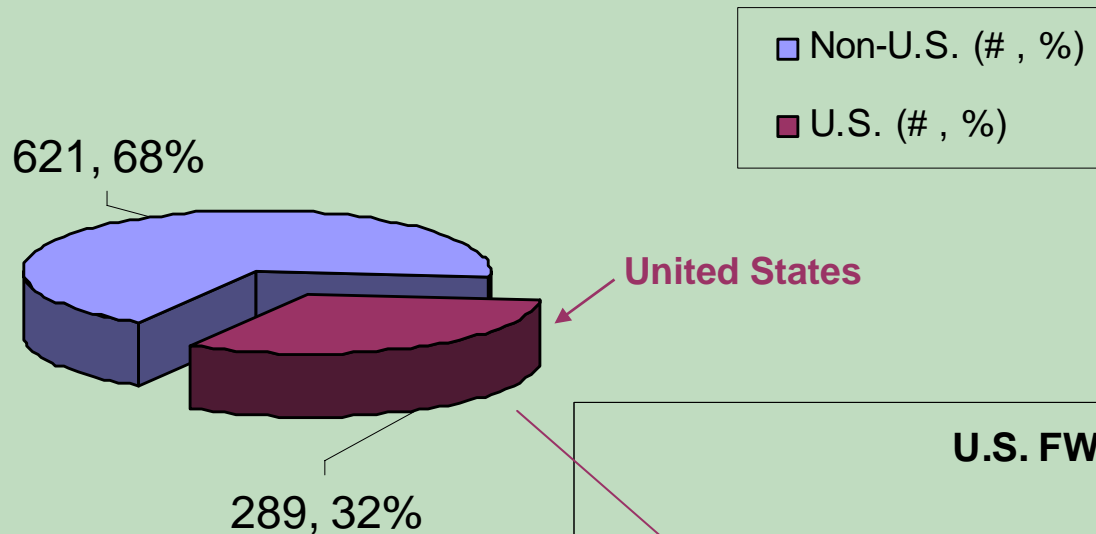
“Western North America”

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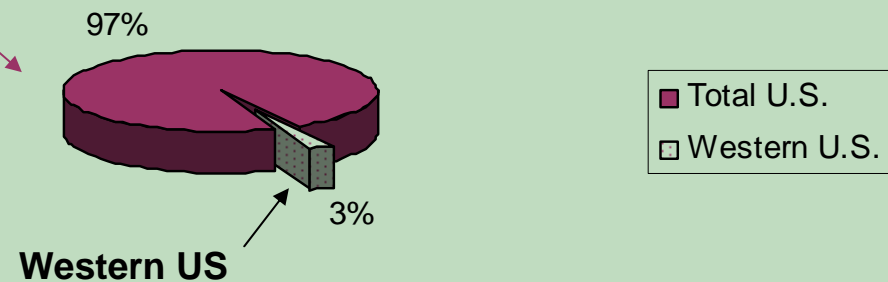
North America West of the
Continental Divide

Freshwater Mussel Distribution

Global FW Mussels

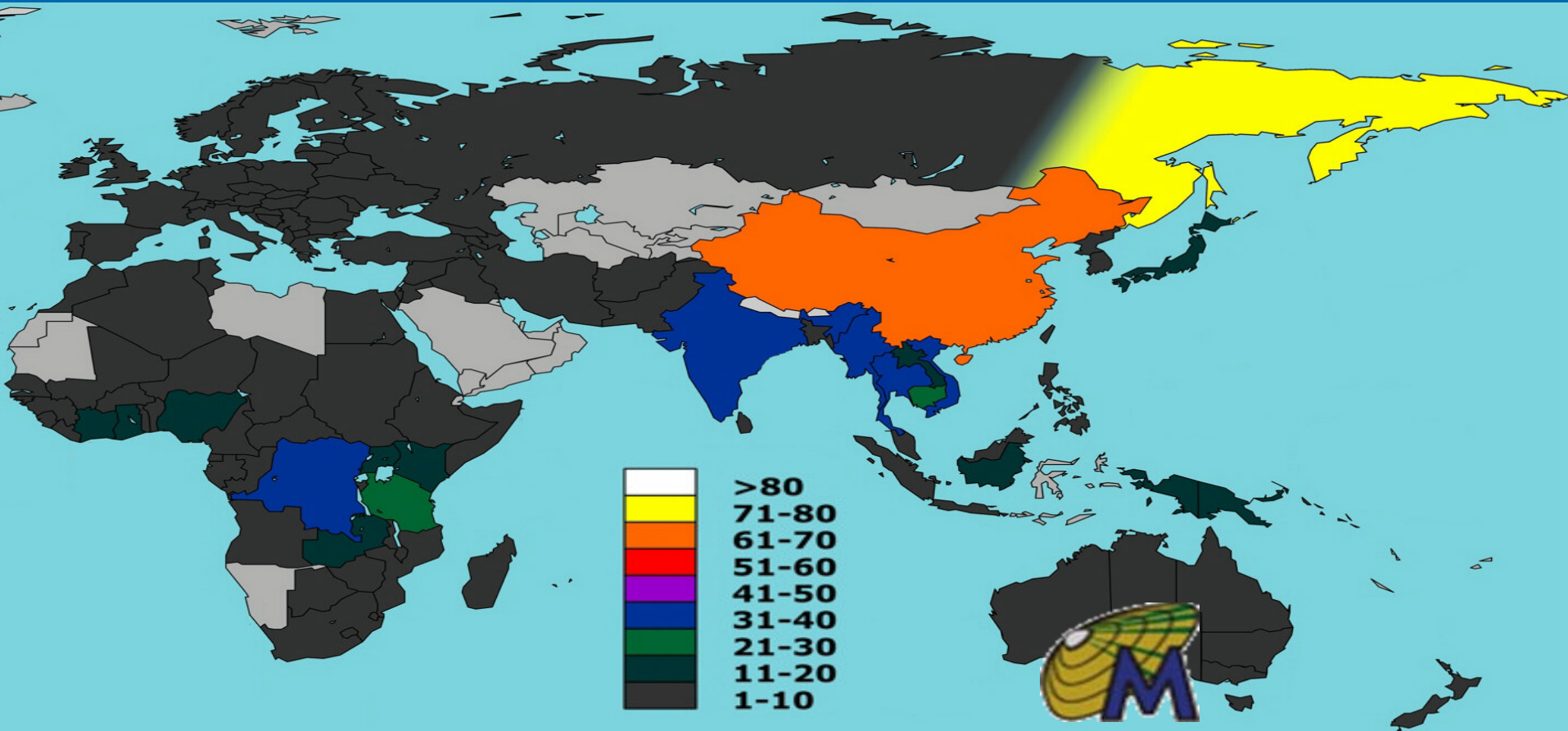


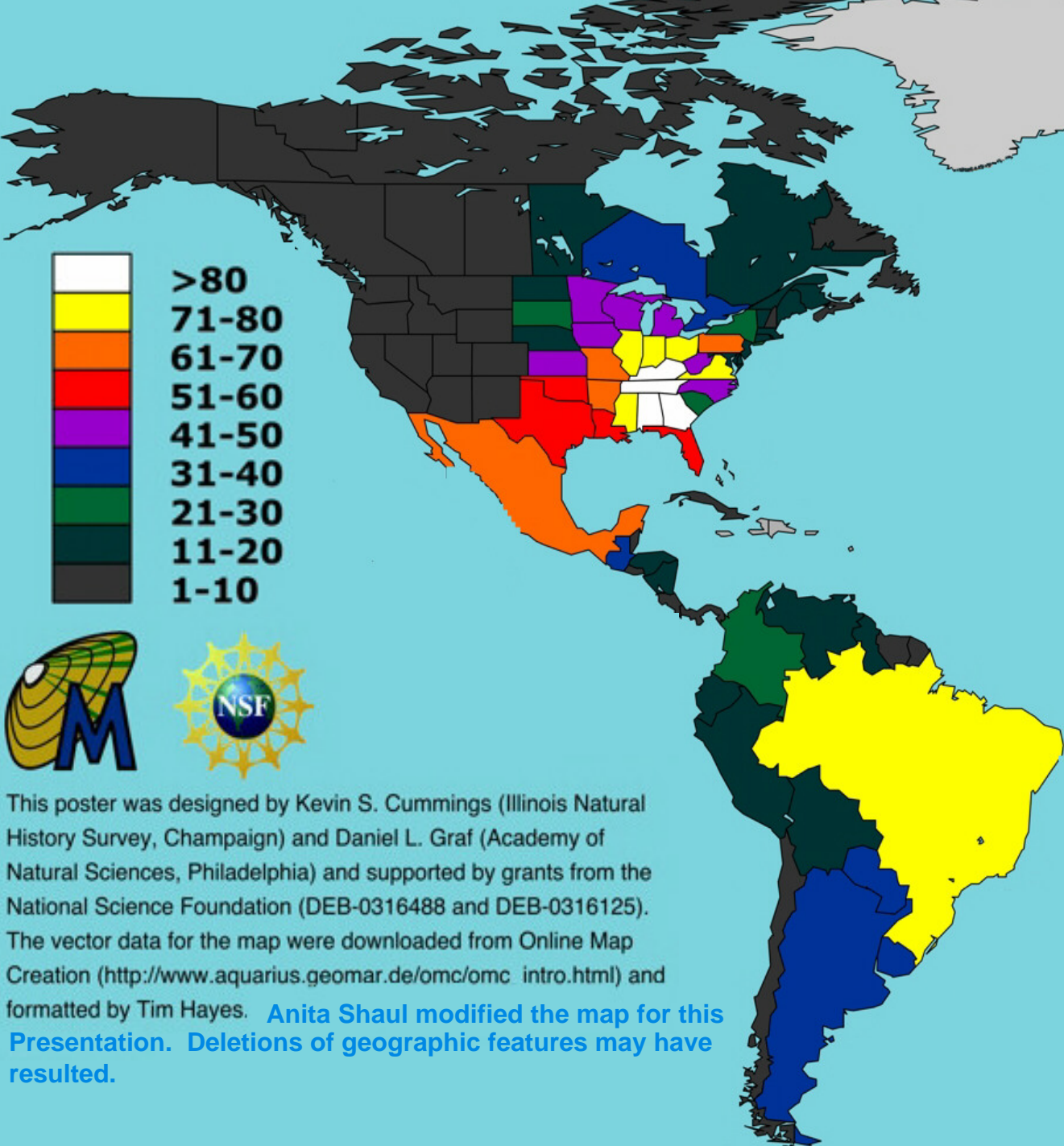
U.S. FW Mussels



FW MUSSEL DIVERSITY

Eastern Hemisphere





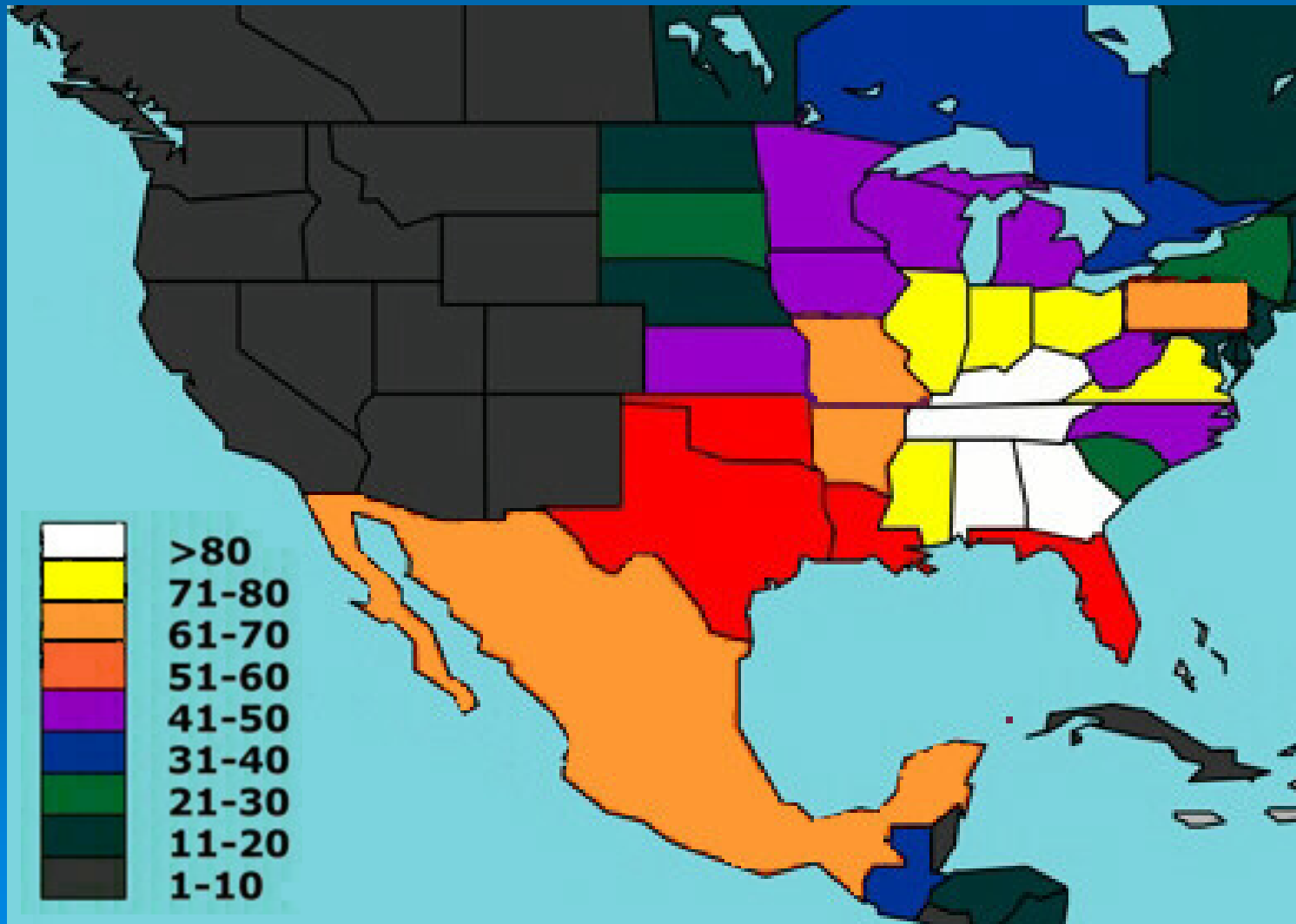
FW MUSSEL DIVERSITY

Western Hemisphere

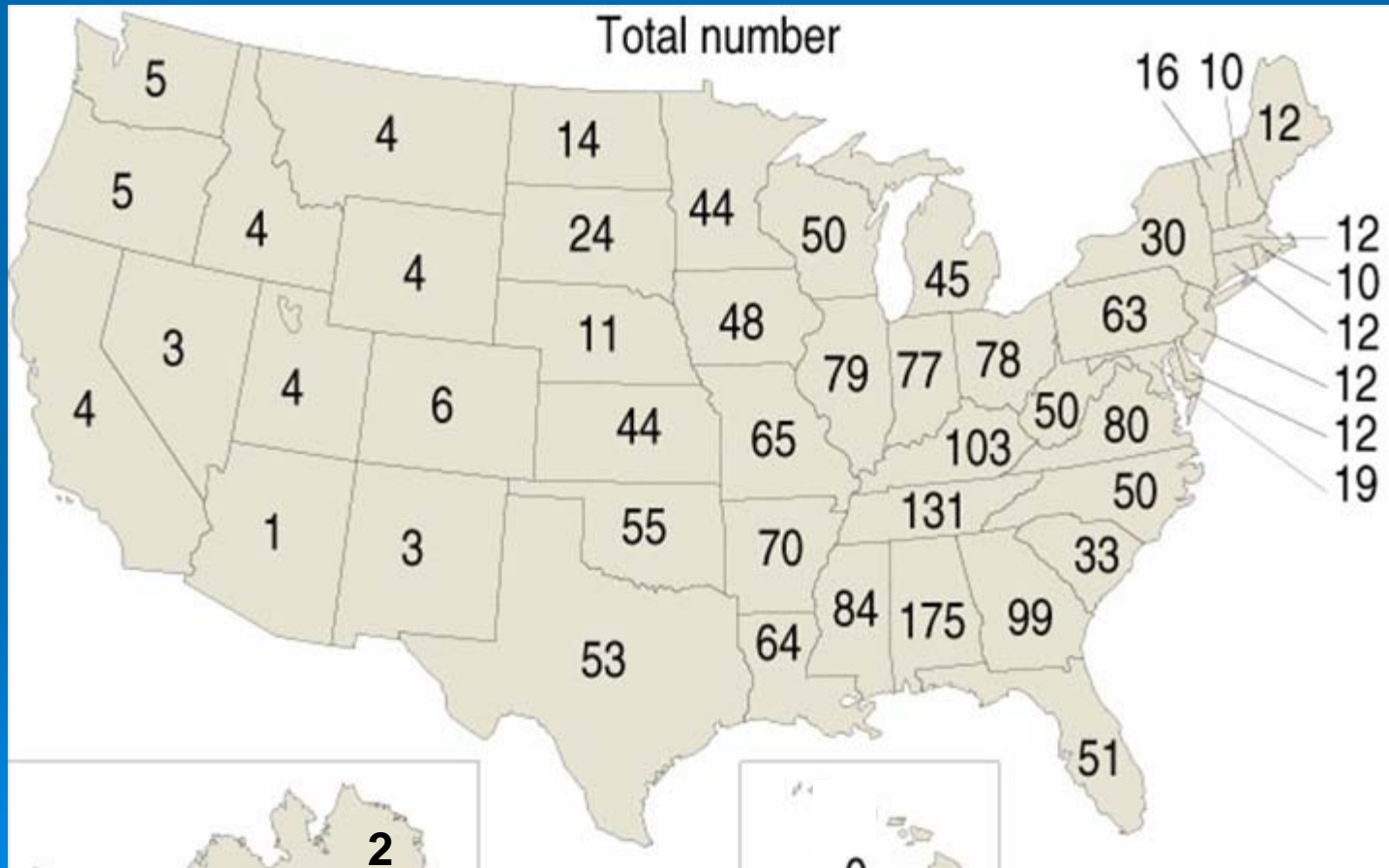
This poster was designed by Kevin S. Cummings (Illinois Natural History Survey, Champaign) and Daniel L. Graf (Academy of Natural Sciences, Philadelphia) and supported by grants from the National Science Foundation (DEB-0316488 and DEB-0316125). The vector data for the map were downloaded from Online Map Creation (http://www.aquarius.geomar.de/omc/omc_intro.html) and formatted by Tim Hayes. **Anita Shaul modified the map for this Presentation. Deletions of geographic features may have resulted.**

FW MUSSEL DIVERSITY

North America



Number of species of freshwater mussels historically thought to occur in each state (Williams & Neves 1995)



Western U.S. FW Mussel Genera



Gonidea angulata



Margaritifera falcata



Anodonta sp.

Western FW Mussels by State/Province

Scientific Name**	Common Name	USA												Mexico
		NV	UT	ID	AZ	CO*	WY*	NM*	MT*	CA	OR	WA	AK	
<i>Margaritifera falcata</i>	Western pearlshell	X	X	X			X		X	X	X	X	X	
<i>Gonidea angulata</i>	Western ridged mussel	X		X						X	X	X		
<i>Anodonta sp.</i>	Floater	X	X	X	X		X		X	X	X	X	X	X
<i>A. glauca</i>														X?
<i>A. tehuatepecensis</i>														X?
<i>Anodonata californiensis</i>	California floater	X?	X?	X?	X?		X?			X?	X?	X?		X?
<i>Anodonata nuttalliana</i>	Winged floater	H?	X?							X?	X?			
<i>Anodonata oregonensis</i>	Oregon floater	X?	X?							X?	X?	X?		
<i>Anodonata kennerlyi</i>	Western floater	H?		X							X?	X?	X?	
<i>Anodonata beringiana</i>	Yukon floater										X?		X?	
<i>Anodonta dejecta</i>	Woebegone floater													

* Only part of the state/province is west of the Continental Divide

** All are of family Unionidae, except the western pearlshell, which is family Margaritiferidae

H = historical

NOTE: The taxonomy of *Anodonta* is in flux and morphological characteristics and genetics are sometimes not in agreement.

A rangewide phylogeography study for all three of the western mussel genera is in progress and these tables may be amended as a result of those studies

FRESHWATER MUSSEL HABITATS



Faster waters:

Gonidea

Margaritifera

Slower waters:

Anodonta



Stream species – Heavy shells




Gonidea angulata
Western Ridged Mussel


Margaritifera falcata
Western Pearlshell



Margaritifera & *Gonidea in situ*



Margaritifera falcata



Gonidea angulata

Photos by Jane Brim-Box

Slow water species – thinner shells

LAKES, RESERVOIRS, SLOW SECTIONS OF STREAMS

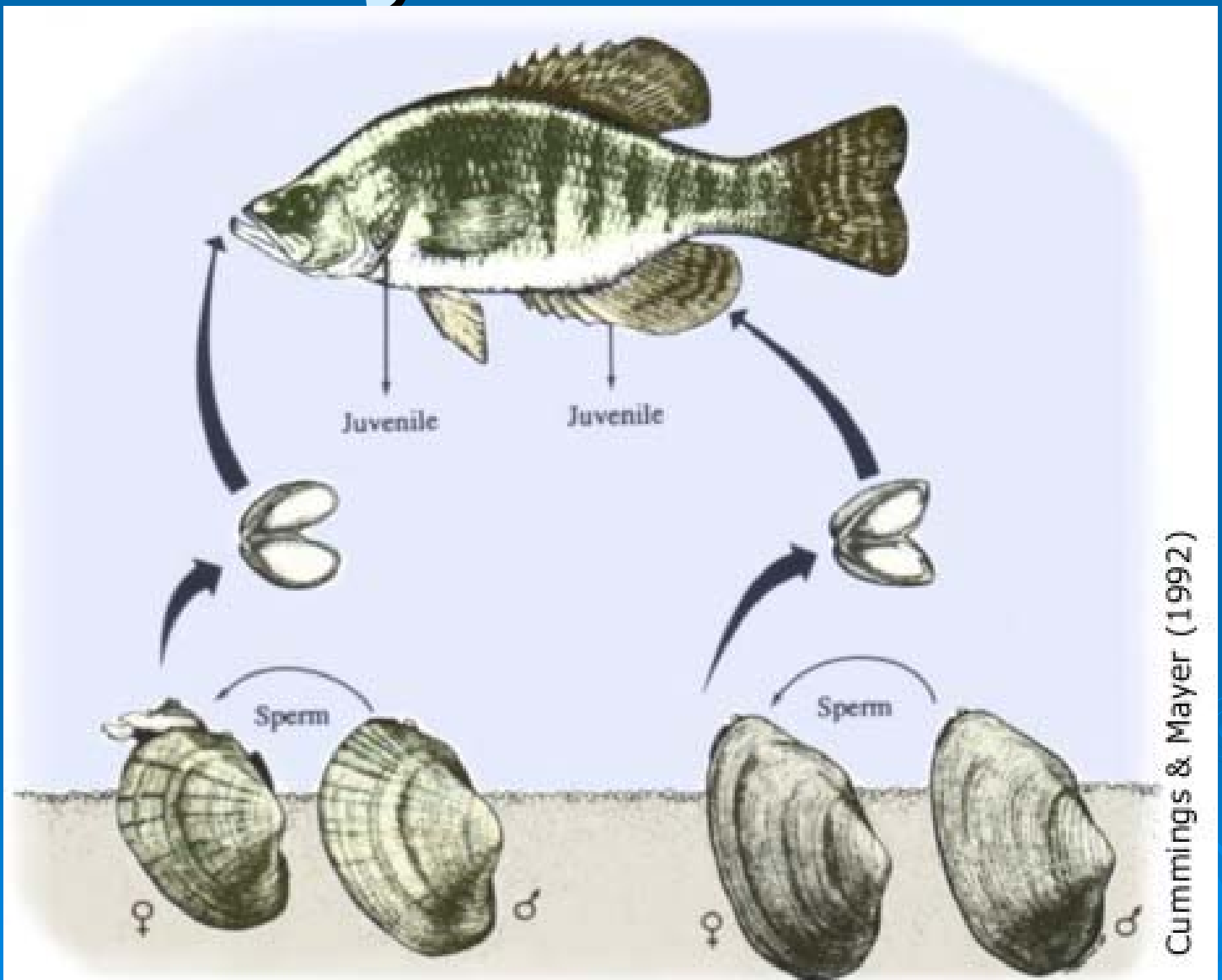


Anodonta *in situ*



Photo by Jane Brim-Box

Life Cycle



The freshwater mussel life-cycle (Unionidae).

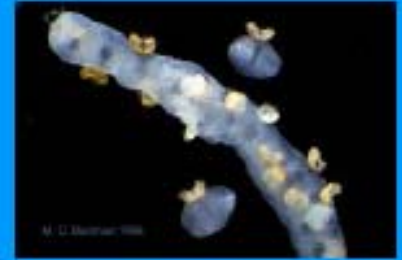
Cummings & Mayer (1992)

GLOCHIDIA – WHERE AND HOW



On **Fins**

Mucous “nets”



Active lure



On **Gills**

Food item mimicry



Conglutinates

Active fishing

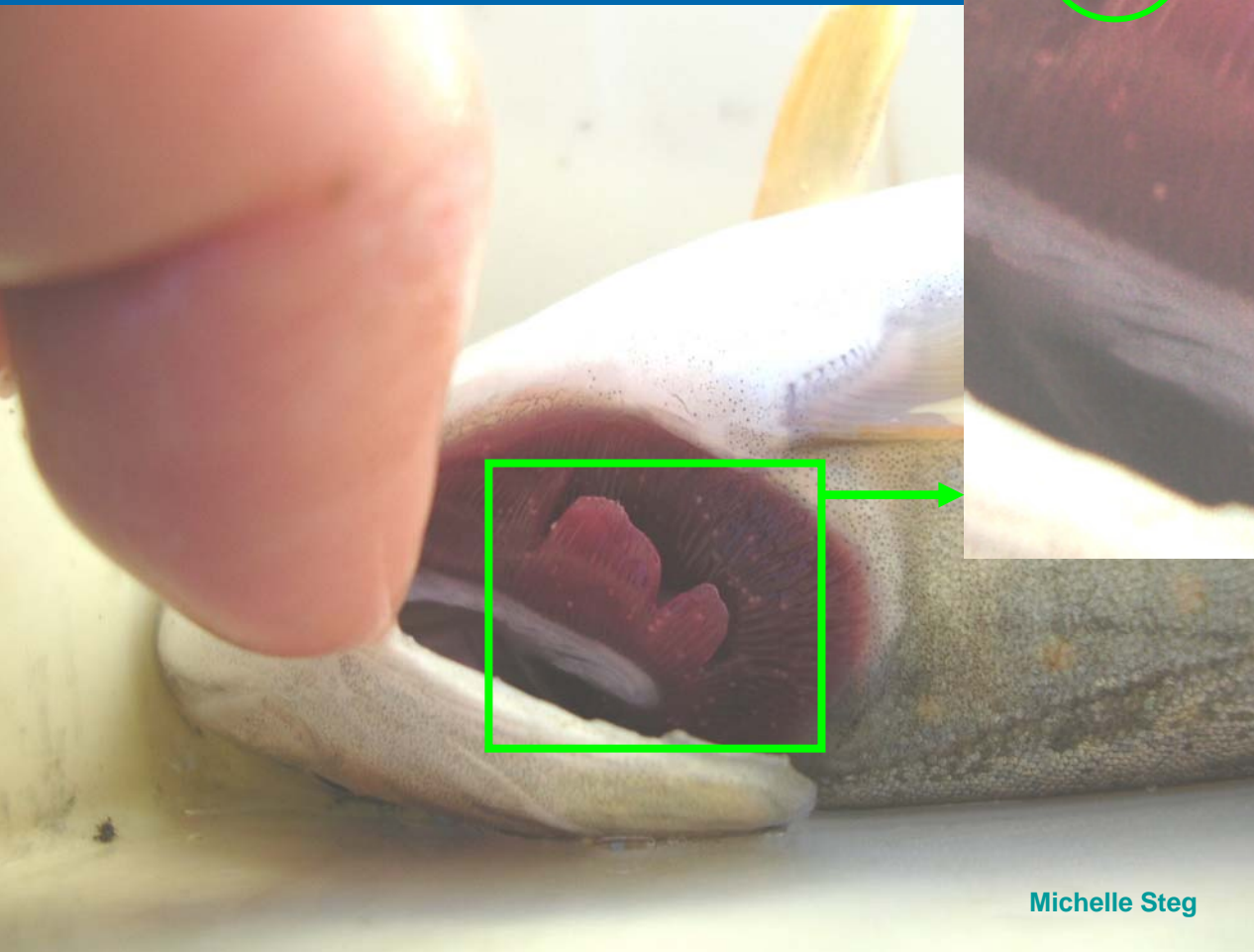


Super conglutinates



Photo by Michelle Steg

Margaritifera falcata glochidia on Bull Trout



Michelle Steg

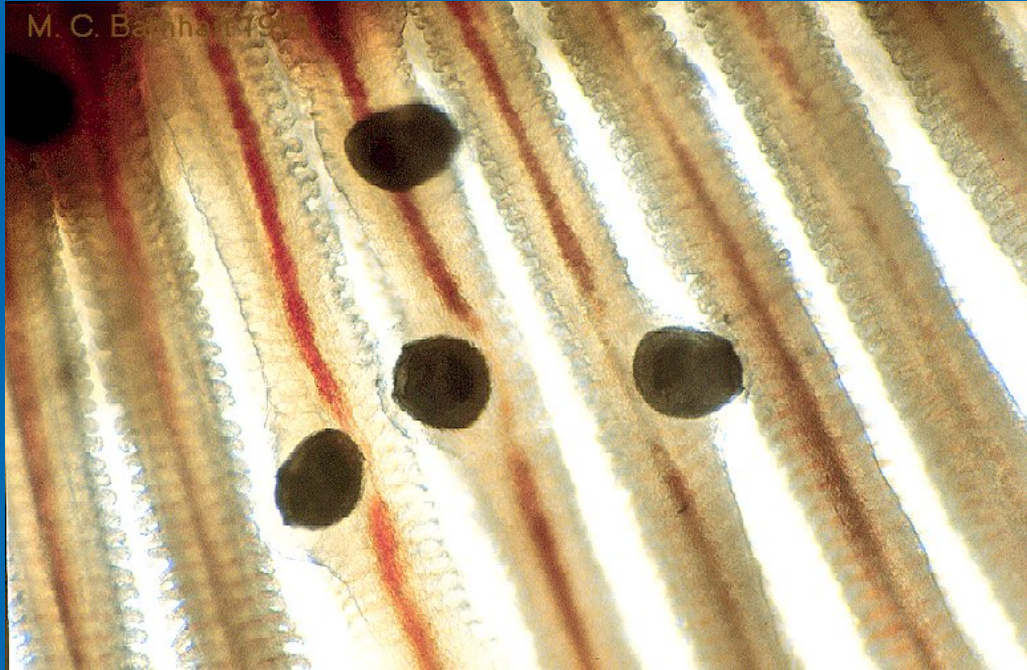
Michelle Steg

GLOCHIDIA On Gills

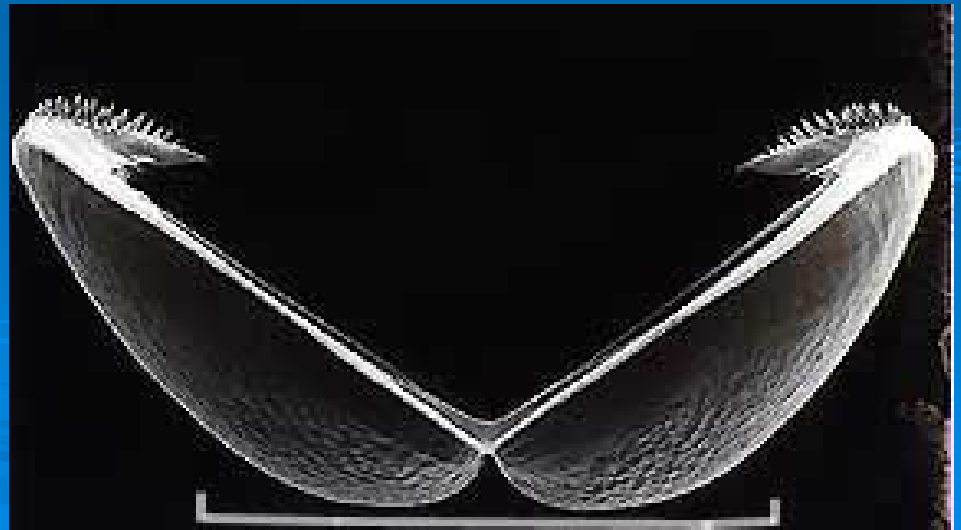
M. C. Barnhart 1998



M. C. Barnhart 1998



M. C. Barnhart



GLOCHIDIA On Fins

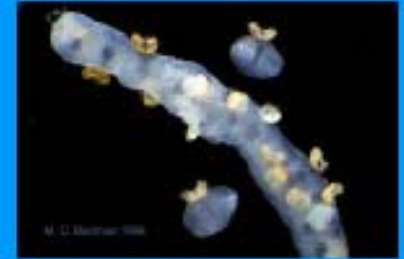


GLOCHIDIA – WHERE AND HOW



On Fins

Mucous “nets”



Active Lure



On Gills

Food item mimicry

Conglutinates



Active fishing

Super conglutinates

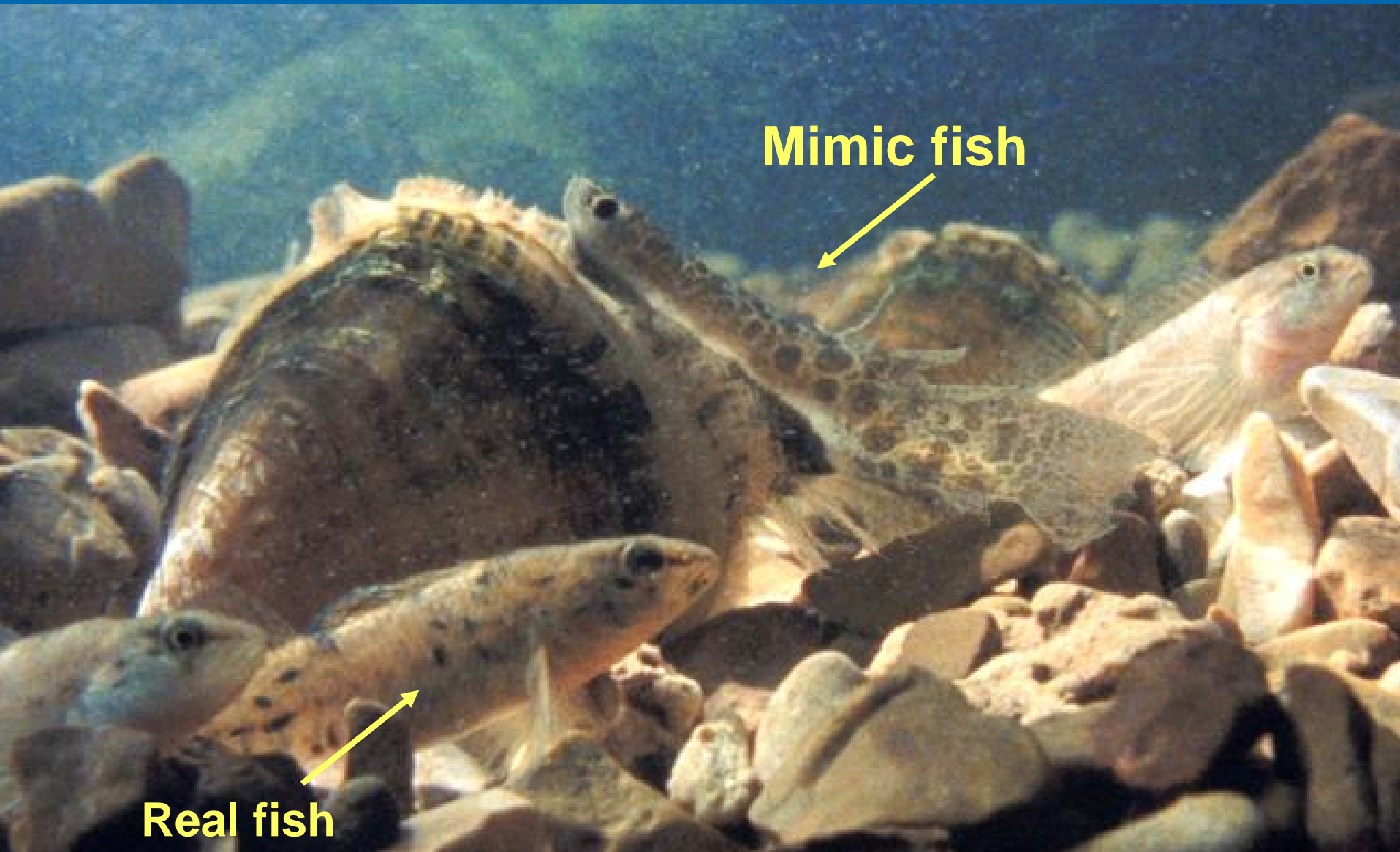


ACTIVE LURES



Images from the Unio Gallery

Mimicking a fish....



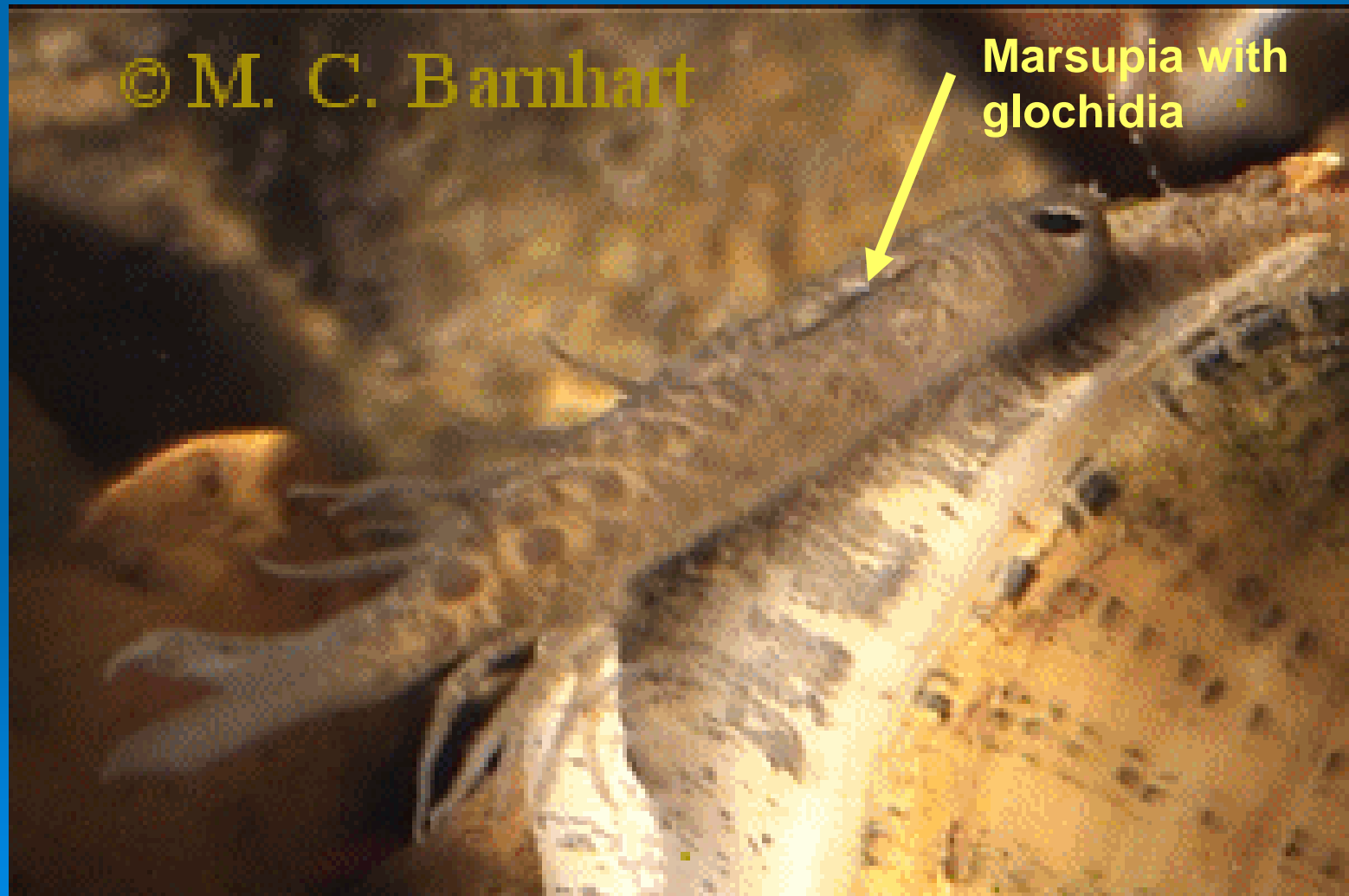
Mimic fish



Real fish



Fish mimic in motion



Mimicking a crayfish (*video clip*)....

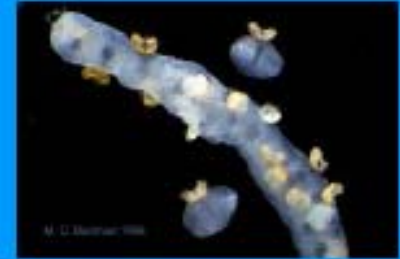


GLOCHIDIA – WHERE AND HOW



On **Fins**

Mucous “nets”



Active lure



On **Gills**

Food Item
Mimicry
Conglutinates

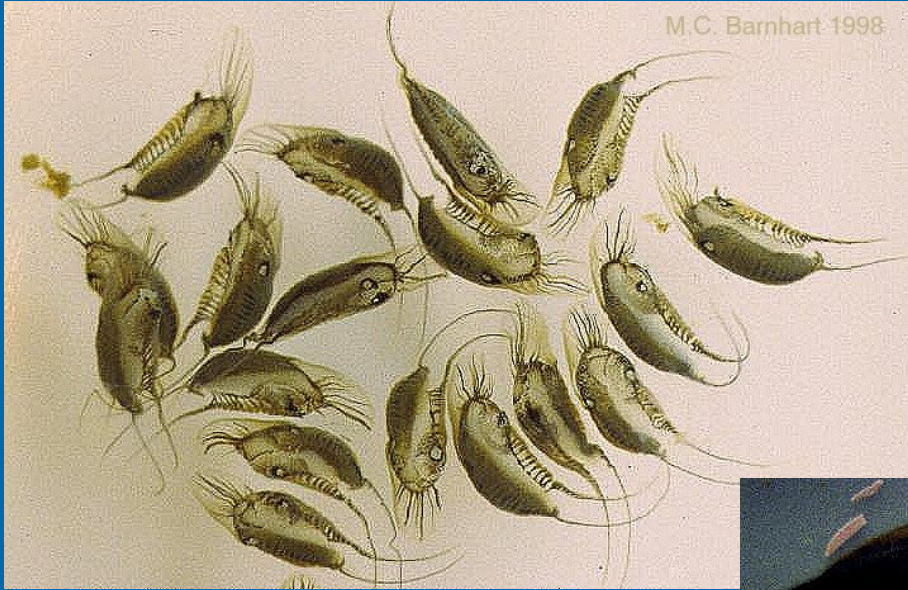


Active fishing

Super conglutinates



CONGLUTINATES, various forms



Conglutinates on a rock....



Same conglutinates up close....



Fish takes a bite (*video clip*)....



From the *Unio* Gallery

Glochidia are released

See white "cloud" that appears to
left of fish in next slide...



From the *Unio* Gallery

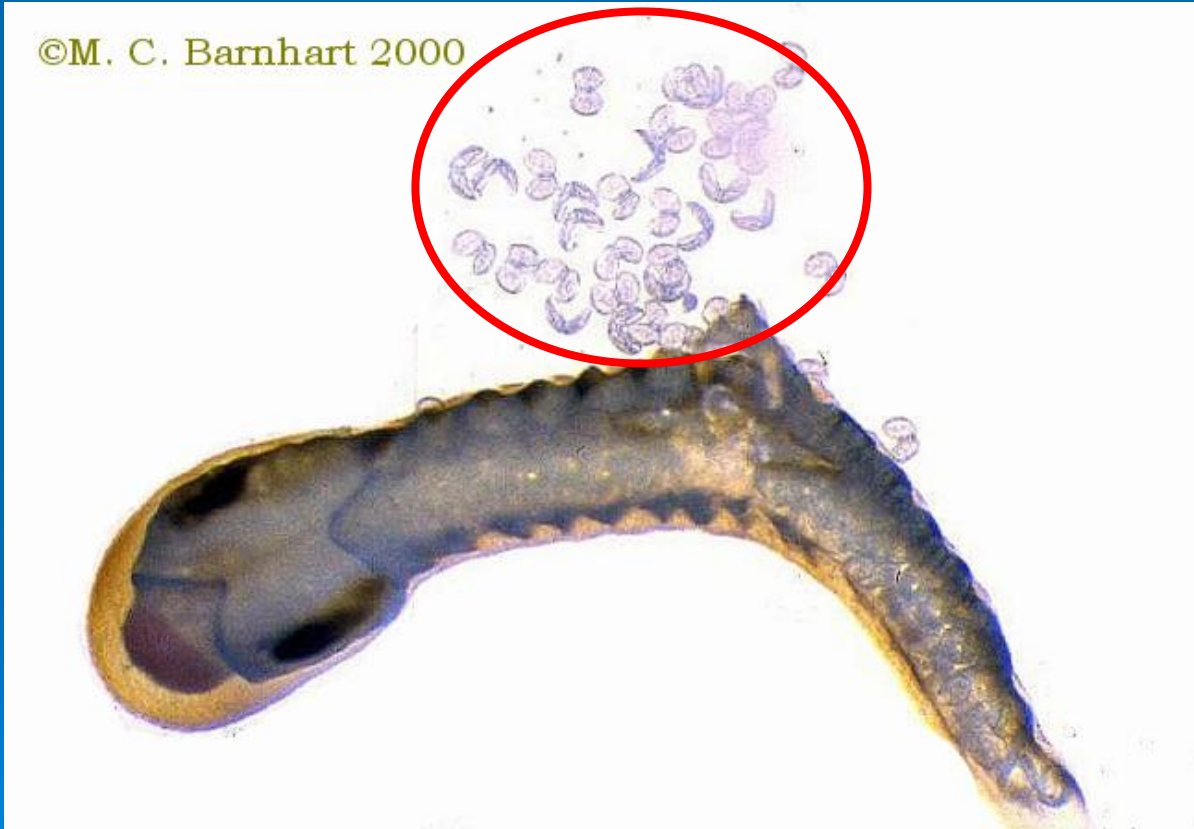
See white “cloud” of glochidia to left of fish...



From the *Unio* Gallery

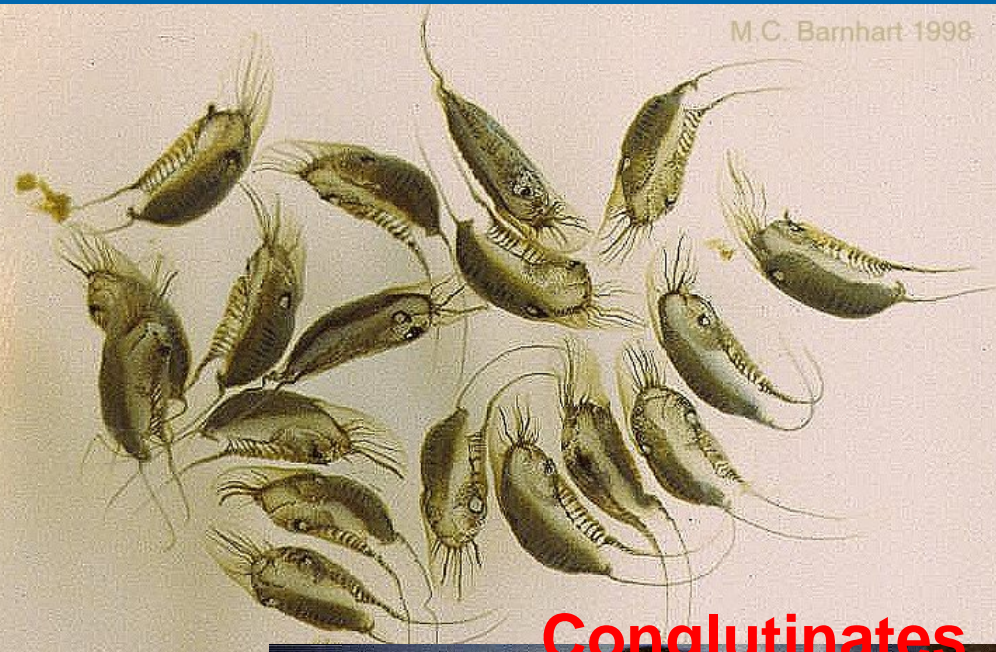
Released glochidia...

©M. C. Barnhart 2000



..attach to
fish's gills.

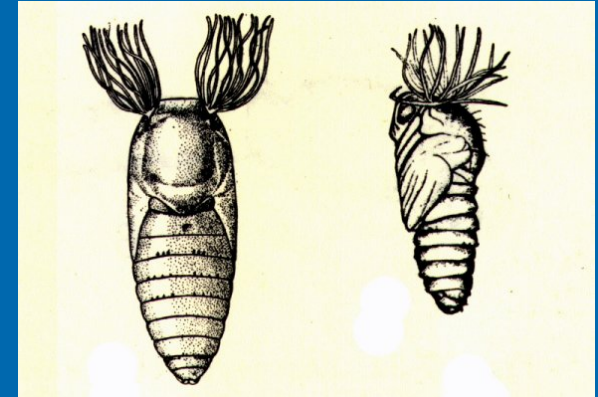
“Fly Fishing” for darters...



Conglutinates



Blackfly pupa

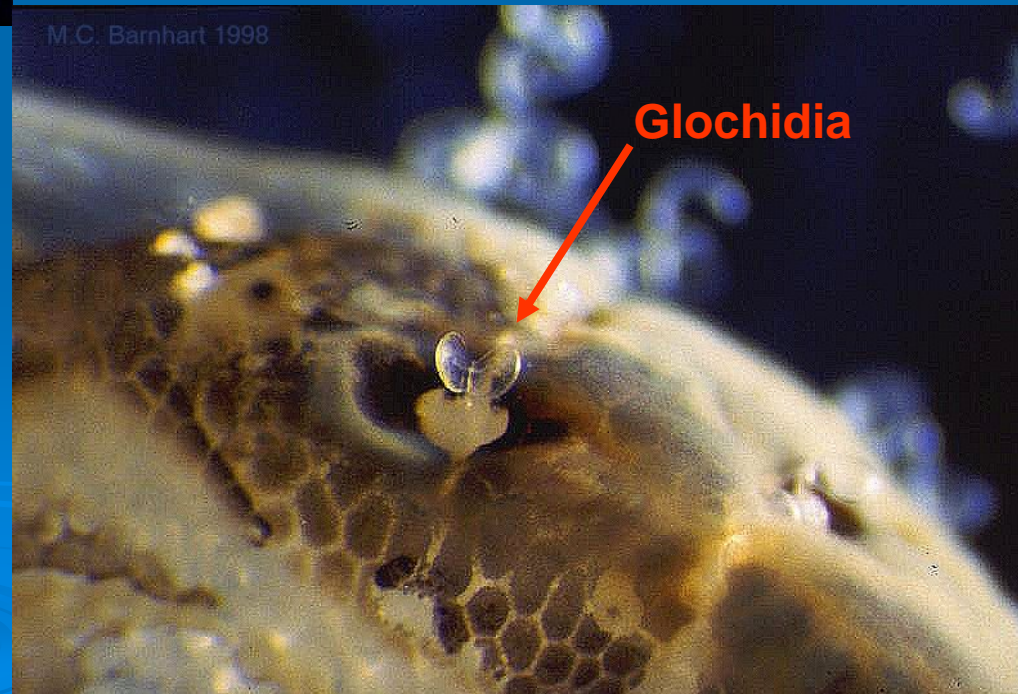
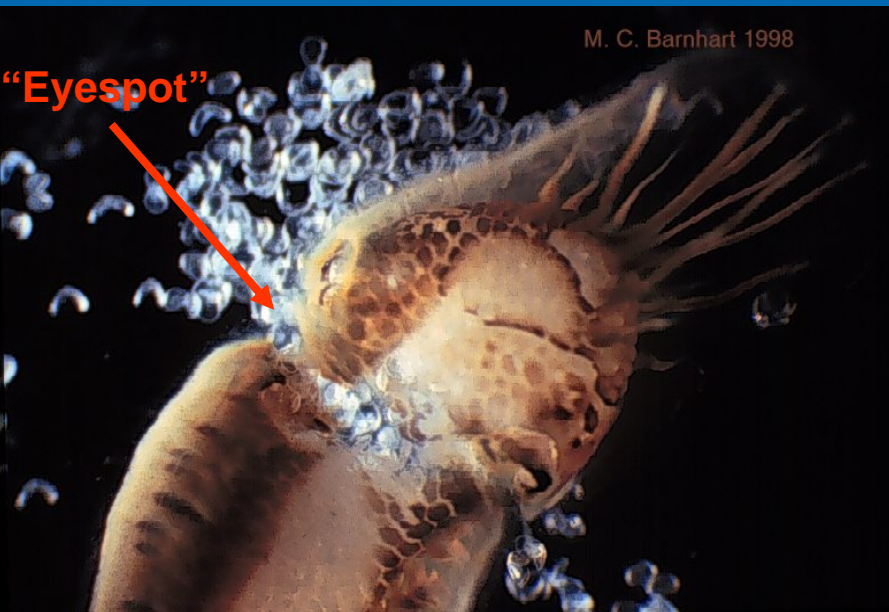
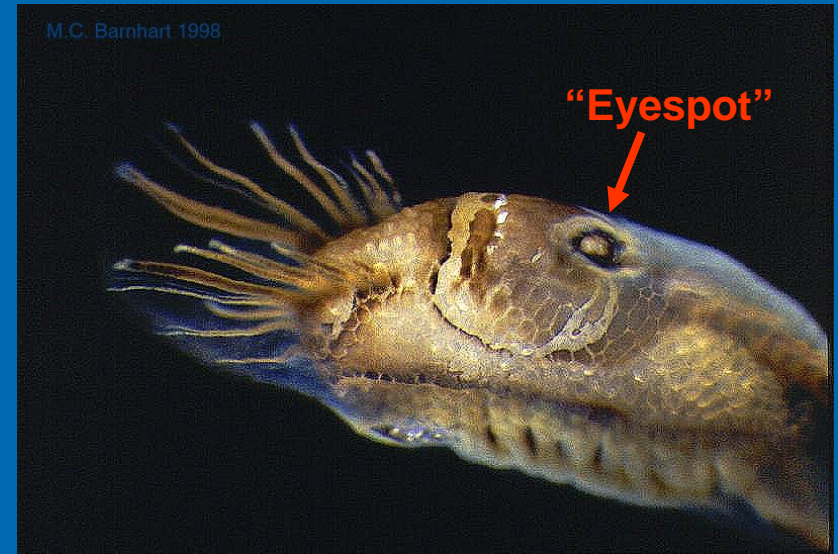
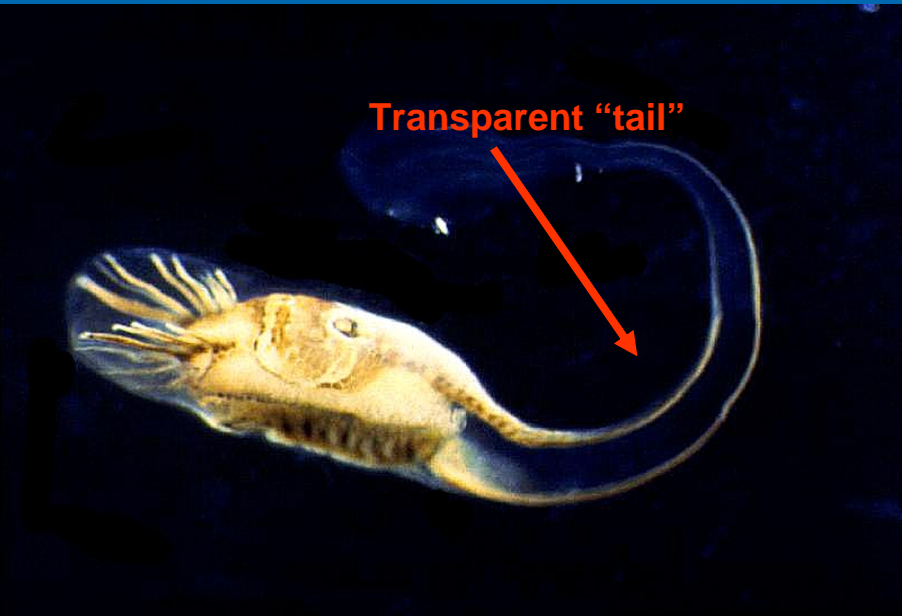


M.C. Barnhart 1998



Fluted Kidneyshell

“Fly fishing” conglutinates, cont.

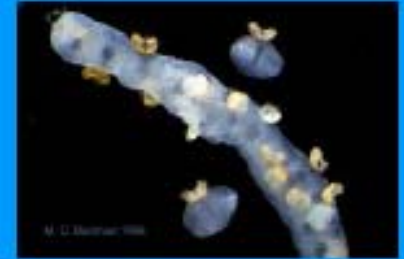


GLOCHIDIA – WHERE AND HOW



On **Fins**

Mucous “nets”



Active lure



On **Gills**

Food item mimicry



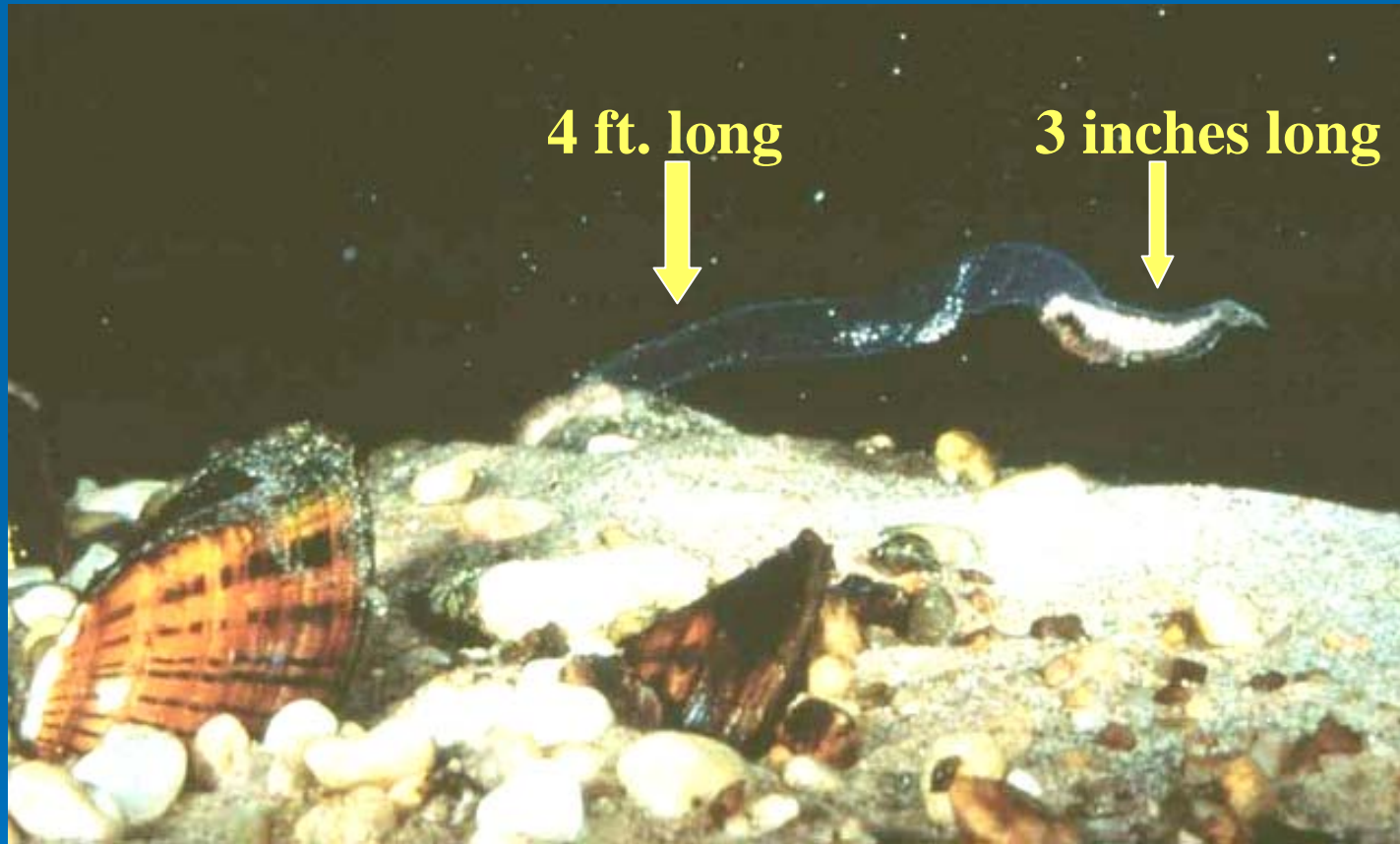
Conglutinates

Active Fishing



*Super
Conglutinates*

SUPERCONGLUTINATES



Lampsilis subangulata – Shinyrayed pocketbook

Described by Isaac Lea in 1840

Super conglutinate lure discovered in 1994

Superconglutinate lures...



A CLOSER LOOK



COLOR VARIANTS



IN MOTION.....



GLOCHIDIA – WHERE AND HOW



On **Fins**



On **Gills**

Mucous Nets

Active lure

Food item mimicry

Conglutinates

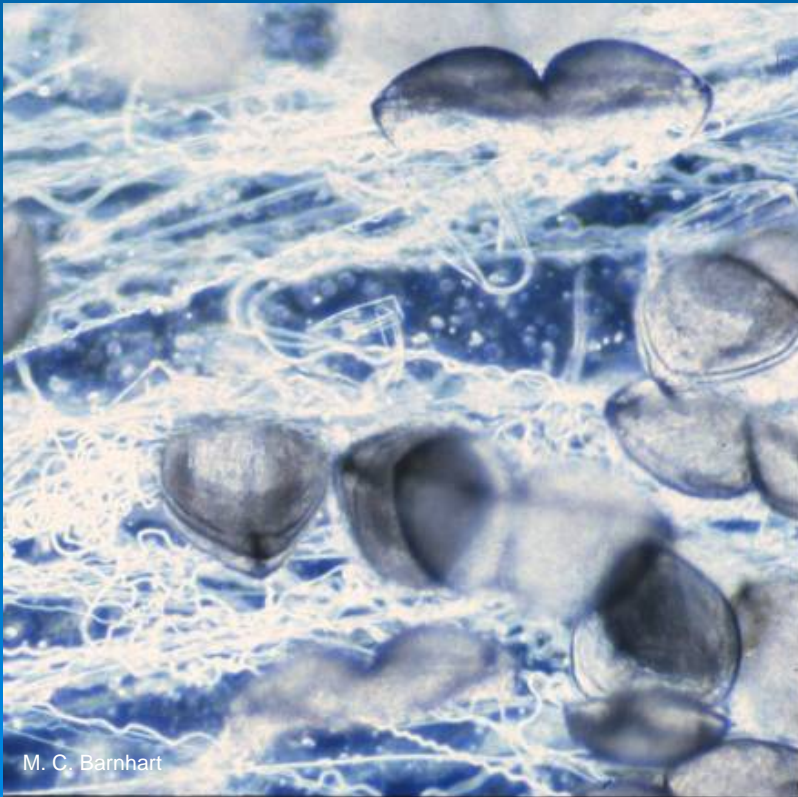
Active fishing

Super conglutinates



Fishing with a net

Larval threads form a network that suspends glochidia in water column (*Anodonta suborbiculata*)



Western U.S. FW Mussel Genera



Gonidea angulata



Margaritifera falcata



Anodonta sp.

WESTERN N.A. MUSSELS & KNOWN SALMONID HOSTS

NOTE: The taxonomy of Anodonta is in flux and these host/mussel relationships may be revised.
Please refer to the Ohio State University website for host information: <http://128.146.250.63/Musselhost/>

FRESHWATER MUSSELS			IDENTIFIED SALMONID HOSTS													
Scientific Name	Common Name		<i>Oncorhynchus tshawytscha</i>	Chinook salmon	<i>Oncorhynchus nerka</i>	Sockeye salmon	<i>Oncorhynchus kisutch</i>	Coho salmon	<i>Oncorhynchus mykiss</i>	Rainbow trout	<i>Oncorhynchus clarki</i>	Cutthroat trout	<i>Salmo trutta</i>	Brown trout	<i>Salvelinus fontinalis</i>	Brook trout
<i>Anodonata californiensis</i>	California floater															
<i>Anodonata nuttalliana</i>	Winged floater	*														
<i>Anodonata oregonensis</i>	Oregon floater						NS									
<i>Anodonata kennerlyi</i>	Western floater	*														
<i>Anodonata beringiana</i>	Yukon floater		NI		NI											
<i>Margaritifera falcata</i>	Western pearlshell**		NT, LT, NI		LT		NT		NT, LT		NT		NT, LT		NT	
<i>Gonidea angulata</i>	Western ridged mussel	*														

* NONE shown in database

NI - natural infestation; parasite found on wild-caught fish but metamorphosis not observed

NT - as above, but metamorphosis observed

LI - laboratory infestation; fish parasitized in experimental conditions, but metamorphosis not observed

LT - as above, but metamorphosis observed

NS - not stated in original source

** Western pearlshell is in family Margaritiferidae; all others in family Unionidae

WESTERN N.A. MUSSELS & KNOWN NON-SALMONID HOSTS

NOTE: The taxonomy of *Anodonta* is in flux and these host/mussel relationships may be revised.

Please refer to the Ohio State University website for host information: <http://128.146.250.63/Musselhost/>

Scientific Name	Common Name	<i>Gambusia affinis</i>	Mosquitofish	<i>Catostomus tahoensis</i>	Tahoe sucker	<i>Rhinichthys osculus</i>	Speckled dace	<i>Richardsonius egregius</i>	Lahontan redside	<i>Xiphophorus helleri</i>	Swordtail	<i>Gasterosteus aculeatus</i>	Threespine stickleback
<i>Anodonta californiensis</i>	California floater	LT											
<i>Anodonta nuttalliana</i>	Winged floater	*											
<i>Anodonta oregonensis</i>	Oregon floater									NS			
<i>Anodonta kennerlyi</i>	Western floater	*											
<i>Anodonta beringiana</i>	Yukon floater											NI	
<i>Margaritifera falcata</i>	Western pearlshell**			LT		NT		NT					
<i>Gonidea angulata</i>	Western ridged mussel	*											

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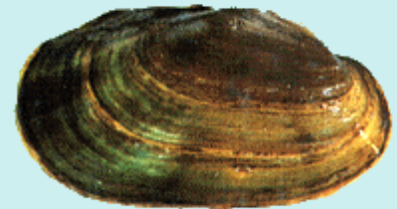
NS - not stated in original source

** Western pearlshell is in family Margaritiferidae; all others in family Unionidae

KNOWN HOSTS OF OTHER F.W. MUSSELS

Unionid: *Toxolasma parvus* (Lilliput mussel)

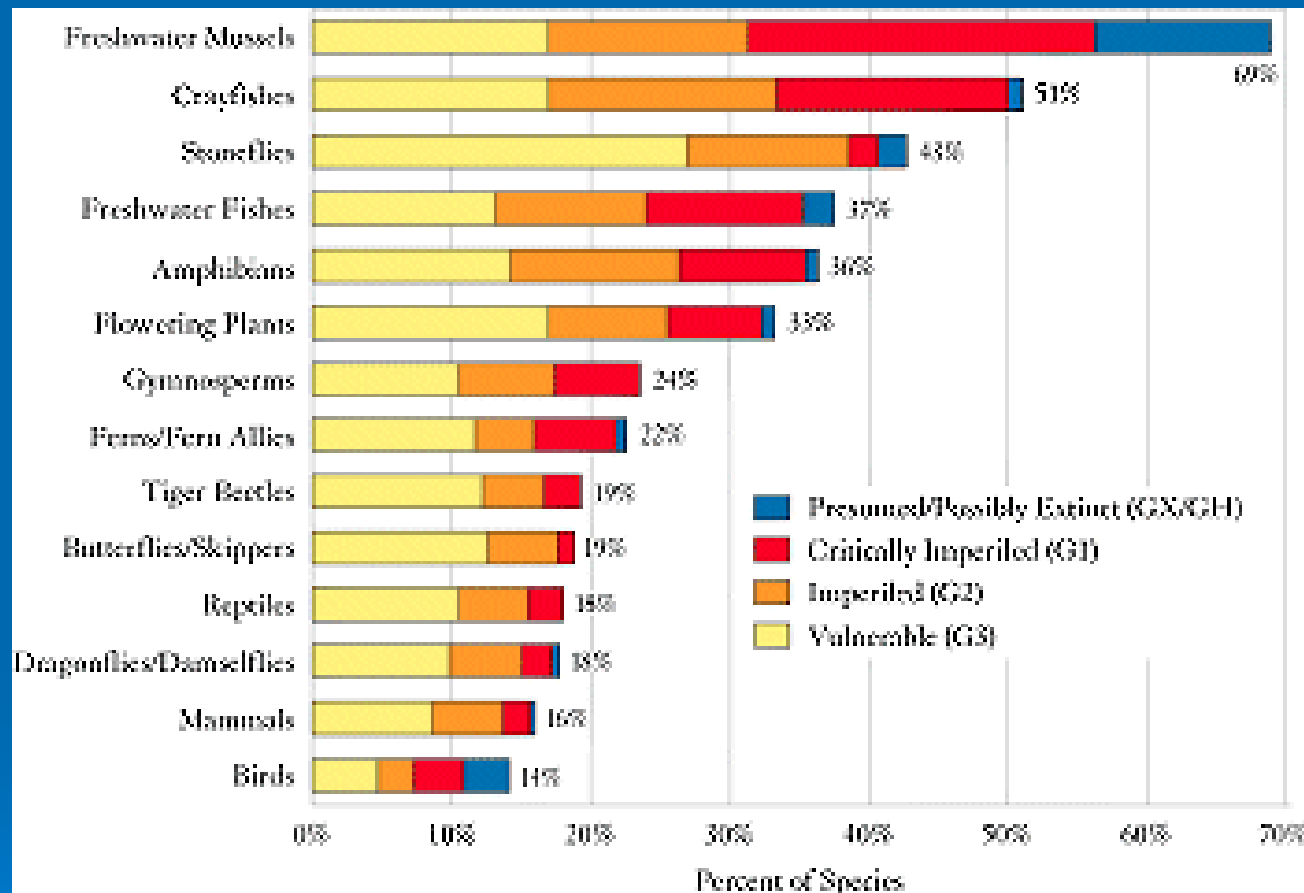
- White crappie
- Green sunfish
- Orangespotted sunfish
- Bluegill
- Warmouth



ECOSYSTEM ROLE

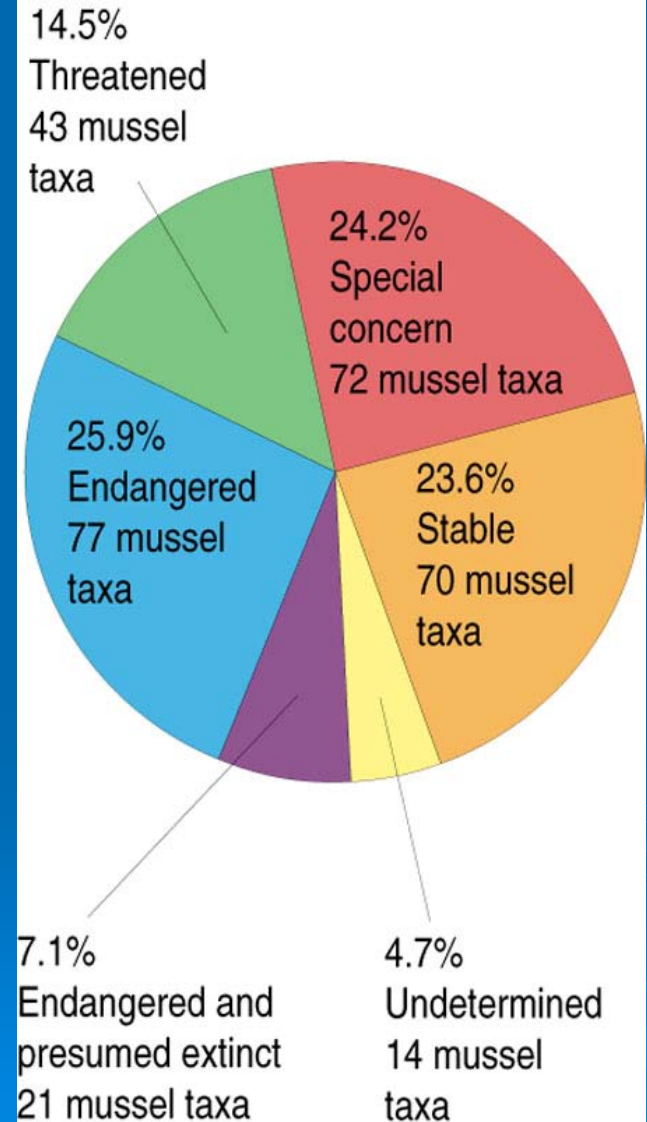
- Water Quality
 - filtering ability
- Bioindicators
 - respond to changes in water quality
- Nutrient Cycling
- Food Web
 - otters, muskrats, water birds

Conservation Status

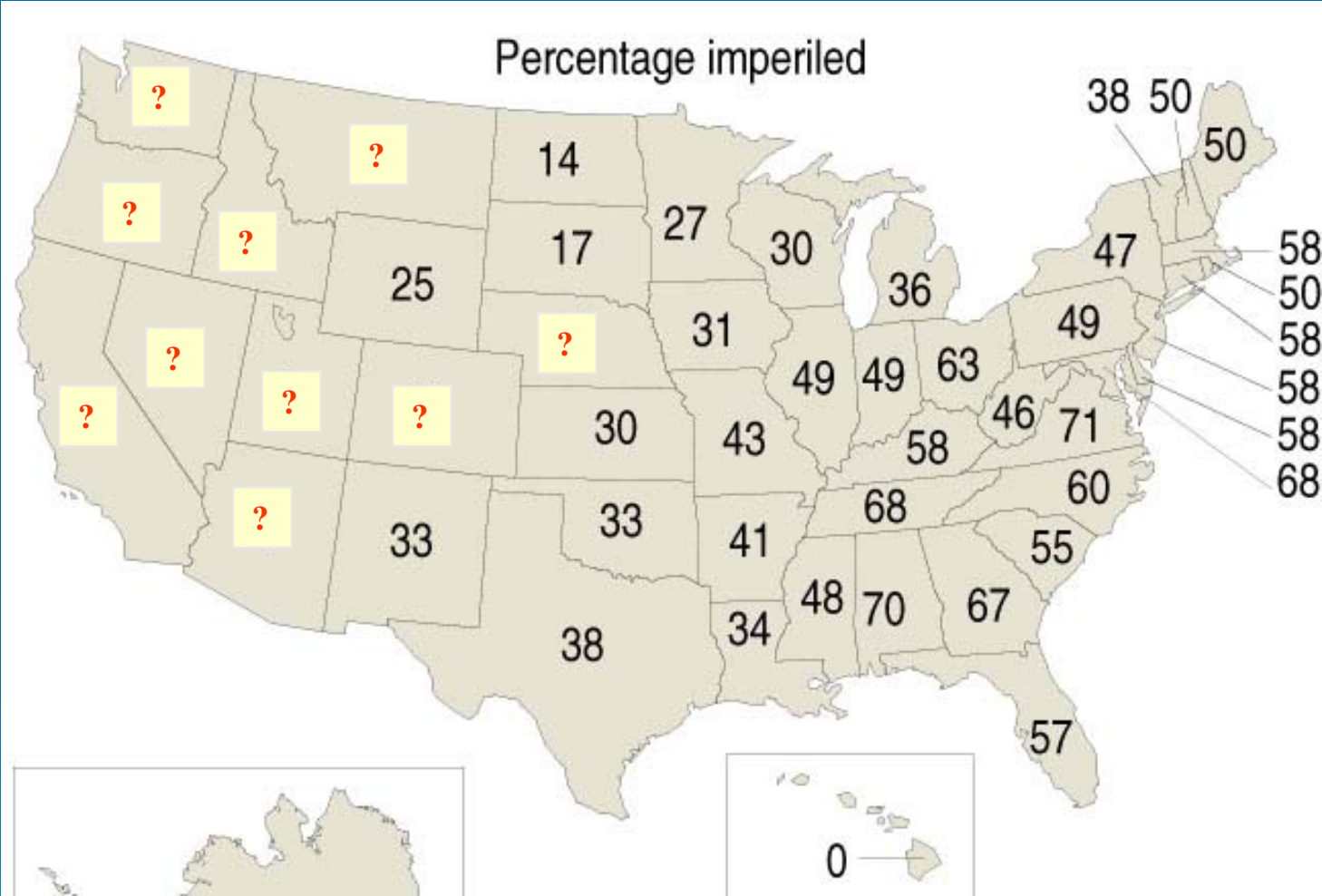


Precious Heritage: The Status of Biodiversity in the United States. 2000. Edited by Bruce A. Stein, Lynn S. Kutner, and Jonathan S. Adams for The Nature Conservancy and Association for Biodiversity Information

Conservation Status in U.S.



Percentage of freshwater mussels at risk by state (Williams & Neves 1995)



THREATS

Habitat Loss

Siltation

Channelization

Dams



THREATS

Indirect Mortality

Loss of glochidial hosts



THREATS

Direct Mortality

Drought

Predation

Toxic chemicals

Competition from alien species

Siltation



HOW CAN YOU HELP?

“Western” Species Lacking:

- Distribution information
- Taxonomic/systematics information
- Host fish information

DATA IS NEEDED

WHAT YOU CAN PROVIDE

- SIGHTING INFORMATION (current or historical)
 - Shells
 - Live mussels
 - *BE SURE TO CHECK WITH YOUR STATE MANAGEMENT AGENCY BEFORE COLLECTING*
 - Glochidia on fish
- GENETICS
 - Karen Mock, Utah State University

Western Freshwater Mussel Guide

http://www.fws.gov/pacific/columbiariver/mwg/pdfdocs/Pacific_Northwest_Mussel_Guide.pdf

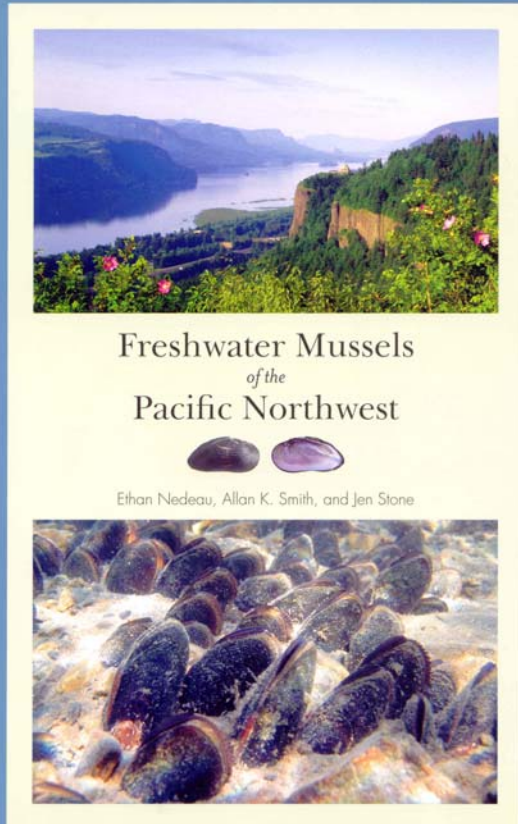
- Ethan Nedeau, bioDRAWversity
- Allan K. Smith

Pacific Northwest Freshwater Mussel Workgroup

- Jen Stone USFWS
- Xerces Society
- Water Tenders

NOTE: The taxonomy of Anodonta is in flux and morphological characteristics and genetics are sometimes not in agreement.

A rangewide phylogeography study for all three of the western mussel genera is in progress and these tables may be amended as a result of those studies.



Although the cover says "of the Pacific Northwest", the suite of freshwater mussels covered in the guide apply to all mainland states west of the Rocky Mountains, though not all species are found in each state, and, as noted above, taxonomy of Anodonta is in flux.

CONTACT INFORMATION

State/Province Contacts for mussel sightings:

State	Contact	Affiliation	Email	Phone
Nevada	Anita Shaul	Nevada Department of Wildlife	acook@ndow.org	775-688-1532
Utah	George Oliver	Utah Div. of Wildlife Resources-Heritage Program	georgeoliver@utah.gov	801-538-4820
Arizona	Jeff Sorensen 2/	Arizona Game and Fish	jsorensen@azgfd.gov	602-789-3740
Arizona	Dan Cox 1/	Arizona Game and Fish	dc Cox@azgfd.gov	602-789-3361
Idaho	Bill Bosworth	Idaho Fish and Game- Conservation Data Center		208-287-2733
Colorado*		Colorado Division of Wildlife		303-297-1192
Wyoming*	Gordon Edwards	Wyoming Game and Fish	gordon.edwards@wgf.state.wy.us	307-473-3418
New Mexico*				
Montana*	David Stagliano	Montana Natural Heritage Program	dstagliano@mt.gov	406-444-7329
Mexico	Dr. Edna Garcia Naranjo	Instituto de Biología, UNAM	naranjo@servidor.unam.mx	
Mexico	Karen Mock	Utah State University	karen.mock@usu.edu	435-797-7870

* Part of the state is west of the Continental Divide

1/ Primary contact in State

2/ Backup state contact

Contact for glochidial sightings, and/or providing tissue samples for genetics, and/or current research on taxonomy:

Karen Mock

Utah State University

karen.mock@usu.edu

435-797-7870

ACKNOWLEDGEMENTS

- Chris Barnhart <http://courses.missouristate.edu/mcb095f/gallery/>
- Allan K. Smith – Pacific Northwest Native Freshwater Mussel Workgroup (PNNFMW)
- Jane Brim-Box – Confederated Tribes of the Umatilla Indian Reservation
- Michelle Steg – The Nature Conservancy
- Freshwater Mussels of the Pacific Northwest:
http://www.fws.gov/pacific/columbiariver/mwg/pdfdocs/Pacific_Northwest_Mussel_Guide.pdf
Ethan Nedeau, Allan K. Smith, and Jen Stone; USFWS; PNNFMW, Water Tenders, BioDrawiversity, The Xerces Society
- Southwest Missouri State University - Unio Gallery:
<http://courses.missouristate.edu/mcb095f/gallery>
- Tom Watters, Ohio State University
- Illinois Natural History Survey http://www.inhs.uiuc.edu/cbd/musselmanual/page130_1.html - lilliput image
- National Park Service <http://www.nps.gov/miss/features/mussels/musselpages/lilliput.html>
- Kevin Cummings The Mussel Database Project <http://clade.acnatsci.org/mussel/>
- Kurt Welke, Wisconsin Department of Natural Resources
- Cynthia Tait, Bureau of Land Management, Oregon
- John Fleckenstein, Washington State Department of Natural Resources
- Karen Mock, Utah State University